reproduce the complexity of arborization. We used the larval class IV sensory neuron in Drosophila as the model cell to approach this question.
As class IV neurons display self-similarity over a range scales, the first key morphological parameter we use to study them is their fractal dimension. The fractal dimension of a neuron is a measure of its complexity and has been used to distinguish between classes of neurons. The second morphological parameter of a neuron involves realizing that such a branching structure can be viewed as a binary tree in which neuronal branching points are the nodes. The structure of interest here is the distribution of node depths, where the depth of a node is the number of other nodes between it and the root (i.e., the cell body) on the tree.
Using both analytical techniques and in silico simulations, we made three findings. 1) The fractal dimension was always a monotonically increasing function of the neuron's maximal depth. 2) The observed Gaussian node-depth distributions are achievable via a termination rule in which the probability of branch termination is a sigmoidal function of node depth. 3) The observed node-depth distributions can be qualitatively accounted for by an "inheritance rule", whereby each daughter segment inherits morphological information from its mother segment.
In conclusion, we demonstrate that a set of statistical rules accounts for the fractal dimension and node-depth distribution of class IV neurons.

4005-Pos Board B733
Statistical Constraints on Dendritic Branching Morphology in Drosophila Class IV Sensory Neurons
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The morphology of a neuron is key to its function, but the principles that govern neuronal morphogenesis are not clear. To investigate these principles, we used the larval class IV sensory neuron in Drosophila as a model cell. Class IV neurons have highly branched dendritic morphology. Our specific question is whether this branching morphology arises from purely random processes or whether there exist non-random constraints on morphological parameters such as segment lengths and branching angles.
To measure the statistical characteristics of the dendritic arbors, we imaged class IV neurons by confocal microscopy and analyzed their skeletons using Fiji and Matlab. First, we found that the lengths of dendritic segments, both terminal and non-terminal, followed exponential distributions. Given that the lengths of the dendritic segments are defined by consecutive branch points, this observation suggests that branching events follow a spatial Poisson process. Second, we found that the angles between two daughter segments follow a normal distribution with a mean of 96 degrees and a standard deviation of 31 degrees (n = 465). Because the mean differs from 180 degrees, we conclude that the branching angles are not uniformly distributed. These properties, namely the distributions of segment lengths and angles, were observed throughout morphogenesis.
Our results indicate that there are morphological properties of class IV neurons which are not determined by purely random processes.

4006-Pos Board B734
Mismatch Between the Resting Membrane Potential and the Voltage at Maximum Amplification in Outer Hair Cells (OHCS) of Mammalian Cochlea
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OHCs amplify sound by an electromechanical mechanism. Sound-induced vibrations cause OHC membrane potential (E) to change from its resting voltage (E_m) to a new value (E_m+dE). The induced receptor potential (dE) initiates charge movement (Q) and force production to counteract viscous losses incurred by the traveling wave. Q exhibits a sigmoidal function with E and because it is most sensitive to dE at the midpoint (V_m), E_m should equal V_m to ensure maximum amplification. V_m was measured with isolated OHCs extracted from guinea pig with whole-cell patch clamp under constant intracellular pressure in presence of KCNQ4 blocker XE991 ($\geq$ 30 μM) to ensure robust voltage clamp (conductance $<$ 1.5 nS at V_m). After correcting for physiological conditions the results show V_m is coincident with *in vitro* measurements of E_m (Neuron 2011 70: 1143), but a mismatch of 40 mV is apparent when comparing with *in vivo* measurements of E_m made at basal (J. Physiol. 1987 383: 551 and Proc. R. Soc. Lond. B. 1992 247: 97) or apical (J. Neuroscience 1985 5: 1591) regions of cochlea. Results also reveal variation of V_m across the cochlea as a function of a non-uniform charge density of the lateral wall (σ); when σ is uniform V_m is constant, and when σ varies inversely with area of lateral wall (A_{LW})V_m increases monotonically from a hyperpolarized value at the high frequency region of cochlea to a depolarized value at low frequency region. Although the relationship between V_m and σ is satisfying as it reflects the electric field, the disparity between *in vitro* and *in vivo* measurements highlights the need to reconcile them to ascertain the operating position of the amplifier.

4007-Pos Board B735
Remodeling of the Postsynaptic Density: A Macromolecular Signaling Complex
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The postsynaptic density (PSD), a macromolecular protein machine that resides under the postsynaptic plasma membrane, regulates the efficiency of synaptic transmission by stabilizing neurotransmitter receptors in the membrane and organizing signaling molecules within the postsynaptic compartment. Data suggests that synaptic activity results in changes in the protein composition of the PSD and it is hypothesized that these changes lead to structural modifications that explain enduring and stable alterations in synaptic function. However, direct evidence for these structural changes has never been obtained and the extent of remodeling and the mechanisms responsible are not fully understood. Our long term goal is to create a high-resolution molecular model of the PSD that accurately represents the number and 3D relationships between its protein components allowing hypothesis to be generated about how recruitment or loss of specific proteins results in structural alterations at the PSD. The ubiquitin proteasome system (UPS) targets proteins for degradation and is, in part, responsible for modifications of the proteins that compose the PSD. Synaptic activity has been shown to induce proteasomal recruitment into the postsynaptic compartment, that requires prior activity-dependent recruitment of CaMKII, resulting in changes in protein composition of PSDs. Electron cryotomography (ECT) and immunogold labeling were employed to examine the 3D structure of isolated PSDs and to identify scaffold molecules targeted by the UPS. Proteasome levels were found to be highest in PSDs isolated earlier in development, providing evidence that the UPS plays a crucial role in the structural reorganization of PSDs. ECT will also be utilized to examine whether CaMKII functions as a direct scaffold for the proteasome that might serve as a mechanism to spatially restrict protein degradation.

4008-Pos Board B736
Action Potential Collision in Nerves
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It is generally accepted that the collision of two action potentials coming from opposite directions is produced by the mutual annihilation of both signals. The experimental confirmation of this effect was shown by Tasaki in 1949 [1] and their fundings are conforming to the Hodgkin-Huxley model for action potential propagation [2].
In the current work we performed an analogous experiments to these made by Tasaki but using Lumbricus terrestris as an animal model. The collision of two simultaneously generated impulses propagating in orthodromic and antidromic directions were investigated. The experiments have been performed in the extracted ventral cord of Lumbricus terrestris by using double external stimulation and single channel recording. Siurprisingly, the collision of two action potential impulses of orthodromic and antidromic propagation within the median giant axon in the ventral cord haven't showed the annihilation of the two signals as is commonly known. The results are in a good agreement with the soliton model for the nerve signal propagation suggested by Heimburg and Jackson [3].
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4009-Pos Board B737
Modeling and Simulations of Biomechanical Symptoms of Parkinson's Disease
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Patients with Parkinson's disease experience oscillatory motion of body parts (tremor) due to an increased reaction time. The tremor is an early-stage

symptom of Parkinson's disease, but the increased reaction time (the delay in the sensory feedback control) can make it difficult for patients to perform their basic tasks. Biomechanical models with feedback control theory can not only provide diagnostic tools to measure the delay from the nature of tremor, but can also provide a quantitative understanding of how the delay results in other advanced-stage biomechanical symptoms such as stooping. A mechanics-based perspective on how the tremor results from the delay has recently been proposed in [J. Mech. Med. Biol., Vol. 11(5), pp.1017]. We extended the same perspective to develop a proof-of-concept smartphone App for measuring the severity of the disease in terms of the delay from the tremor. We are also developing mechanical models of human body with neural control based on the same perspective to simulate and analyze other biomechanical symptoms of the disease. We expect that such models will provide a novel foundation for improved diagnosis, prognosis, and safer symptomatic treatment strategies.

4010-Pos Board B738

Memristor Neural Model for Alzheimer Disease

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Alzheimer disease is characterized by the formation of a pathological protein agglomerations in the correspondence of the synapses that determine a modification in the conductive signal. With the most recent theory, based on Memristive elements, it has been possible to describe some conductive issues in the neurons not well explained since the Hodgkin and Huxley model. Considering the current's flux as the causing factor of post behavior of the neurons (according to Chua's definition), it is now possible for analyses of some aspects that can give important details in the memory's mechanism of the neurons. Here we report the evidence and the analysis that confirm, or not, Memristor's model, and an accurate characterization of the conductivity in healthy and pathological neurons. All the result received a rigorous electrical approach: DC V-I curves, small-signal admittance, small-signal impedance, pole-zero diagrams, frequency response, Nyquist diagram. We believe that this work will be extremely important for the future develop of new drugs, capable of reestablishing a correct conductivity through the neurons in patients affected by Alzheimer disease.

4011-Pos Board B739

Development of Modularity in the Neural Activity of Children'S Brains

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We discuss how the cognitive ability of the human brain depends on modularity of neural activity. Modularity is a measure of the degree of correlation in the neural activity within different brain regions, and a modular organization of neural activity can facilitate more rapid cognitive function. Modularity enhances cognitive responses because it is easier and faster to rewire connections within the modules than within the entire network. On the other hand, modularity may restrict possible cognitive function at long time scales, because a modular neural architecture is a subset of all possible architectures. Here we studied modularity of neural activity networks in the human brain. We extracted the brain networks from functional magnetic resonance imaging in children and adults under resting conditions. We observed that the value of modularity increases during childhood development and peaks in young adulthood. We discuss interpretation of these results as selection for plasticity in the cognitive function of the human brain. We also describe a model to illustrate how modularity affects cognitive performance at short and long times. Finally, we suggest that modularity can serve as a potential biomarker for injury, rehabilitation, or disease.

4012-Pos Board B740

Feature Detection and Orientation Tuning in the Drosophila Central Brain

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Many animals, including insects, use visual landmarks for orientation and navigation. In Drosophila melanogaster, behavioral genetics studies have identified the central complex as being required for innate attraction to particular visual features, and for short- and long-term memory for visual patterns. Studies in several insects suggest that the region is also important for motor coordination. Here we present an analysis of the first physiological recordings from this region in Drosophila. We focused on neurons implicated in orientation and place memory in the fly: ring neurons of the ellipsoid body, a sub-region of the central complex, We show [1] that each ring neuron sends dendrites to a single microglomerulus in the lateral triangle (LTr), a multi-glomerular brain region that is a major source of input to the ellipsoid body. We studied the responses of complete populations of ring neuron classes using two-photon calcium imaging in head-fixed flies that were flying or walking on an air-supported ball in an LED arena. LTr microglomeruli show retinotopically organized receptive fields (RF) that are tuned to specific orientations and features with excitatory and inhibitory subfields. LTr responses to visual stimuli are diminished during flight, but are not significantly modulated during walking. A simple linear model based on LTr responses recorded during closed-loop flight behavior, is sufficient to compute the fly's heading relative to visual features in its surroundings. We suggest that ring neurons may provide the visual pattern information necessary for a variety of orienting and navigation behaviors in the fly. Our results provide the first evidence for retinotopic maps in higher brain structures in Drosophila, and set the stage for mechanistic studies of sensorimotor integration underlying visually-guided decision-making in this genetic model organism.

[1] Seelig J.D. and Jayaraman, V., Nature, 2013, in press.

4013-Pos Board B741

Prestin Lateral Mobility and Self-Association in Outer Hair Cells

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Prestin belongs to the SLC26 protein family, which regroups anion antiporters capable of transporting monovalent and divalent anions across biological membranes. Also referred to as SLC26A5, prestin is a motor protein essential for the electromotility of the outer hair-cells (OHC) and therefore the amplification of sound in the cochlea. The diffusion of prestin in the membrane has been previously studied through fluorescent recovery after photobleaching (FRAP) experiments, in HEK293 cells. We were able to determine that up to 50% of the prestin population was immotile. This suggest that intermolecular interactions between prestin, the membrane and the cytoskeleton are essential for prestin organization and function. We have created transgenic mouse lines co-expressing prestin-TFP and prestin-YFP. OHCs isolated from these mice have prestin-induced non linear capacitance (NLC) and electromotility comparable to wild-type mice.

FRAP analysis on prestin-YFP indicated that in OHCs, the entire prestin population is immotile. This motility was partially recovered by inhibition of the actin filament polymerization. Fluorescent resonance energy transfer (FRET) coupled to fluorescence lifetime imaging microscopy (FLIM) allowed us to detect and monitor the prestin-prestin interactions at the nanometer scale. These FLIM-FRET experiments revealed a FRET efficiency of 25-35%.

The FRAP experiments suggest a strong interaction of prestin with other membrane proteins or the cytoskeleton, and the high FRET efficiency will allow for prestin-prestin interactions to be monitored during alterations of the membrane composition and potential.

Optical Microscopy and Super Resolution Imaging IV

4014-Pos Board B742

Measurement of the Point- and Line-Spread Functions Enables Deconvolution in Bright Field Light Microscopy

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Bright field is the simplest and most widespread light microscopy modality. However, its use in cellular biology has been limited due to lack of contrast in the imaging of thin, transparent samples such as cells. Instead, more involved microscopy techniques (e. g. differential interference contrast, dark field, phase contrast, among others) have been used. An alternative to increase image contrast is deconvolution processing, a powerful method often used in fluorescence microscopy. However, application of deconvolution processing to bright field images has been scarce, mainly because acquisition of the point-spread function (PSF) has been difficult. In this work, we present direct measurements of the point- and line-spread functions of a high-aperture microscope operating in bright field. Polystyrene nanoparticles of 100 nm in diameter and cytoskeletal microtubules serve as the point and line objects, respectively, that are imaged with high contrast and low noise using conventional microscopy plus digital image processing. To our knowledge, this is the first report that describes the experimental assessment of these functions. Our experimental results are in good agreement with a proposed model for both point- and line-spread functions. The measured PSF allows us to demonstrate conventional deconvolution on the bright field images of living, unstained